forest MANAGEMENT bulletin

CHEMICAL CONTROL OF VEGETATION IN SOUTHERN FORESTS

by
H. L. Williston, W. E. Balmer
and L. P. Abrahamson*

NOVEMBER 1976

Published by S. E. Area, State and Private Forestry — USDA Forest Service — 1720 Peachtree Rd., N. W. — Atlanta, Georgia 30309

THE OPPORTUNITY

Deadening hardwoods on land where pine reproduction occurs naturally is a much cheaper means of establishing a pine stand than "starting from scratch" and planting trees. The use of chemicals is the most economical and fastest way to convert some 20 million acres of nonproductive land in the South to valuable pine forests. In fact, much of the pine timber being cut today is the result of releasing young pine from hardwood competition in years past. Although more difficult to prescribe, similar timber stand improvement is needed in the bottomland and upland hardwood stands of the South in order to produce higher quality timber.

In the early days, hardwoods were cut, girdled or frilled with an axe. But where stems were 10 inches in diameter or less, sprouting was generally profuse. This unwanted result led to the use of chemicals, which are applied today by various means.

TREE INJECTORS

Tree injectors are metered to discharge various amounts of undiluted herbicide into each incision. The incisions are generally made within several inches of the groundline, although they have been effective when made as much as 12 inches above ground. The amount of herbicide required to kill a tree varies by species, season of treatment, spacing of incisions, site, and tree size. Large trees are more difficult to kill than small ones, so dosages should be doubled for trees larger than 9 inches in diameter.

For greatest savings, treatments must be varied by season and species. If a crew is not trained to recognize species and vary the treatments accordingly, guidelines must be simplified. For example, in north Mississippi, where the crews use injectors with 3 inch bits sharpened on the downside, incisions are spaced 2 inches apart, edge-to-edge, for all species except hickory, blackgum, Eastern redcedar, and red maple. For these hard-to-kill species, the incisions are made edge-to-edge so that they are completely frill girdled. One milliliter of 2,4-D amine is injected into each incision.

The incisions must go through the bark and into the cambium. It takes an extra effort to satisfactorily inject hickory and trees 12 inches in diameter and larger. Because labor costs are constantly increasing, chemicals are needed that can be applied at wide spacings. In tests with blackjack oak, mockernut hickory, and sweetgum in central Lousisiana, several herbicidal mixtures were more effective than 2,4-D alone. Picloram + 2,4-D (which is the Tordon 101 mixture of weed and brush killer) injected at 7- and 9-inch spacings in January, was particularly effective for pine release, resulting in a topkill of 90 percent or better. Tordon 101 is more lethal than 2,4-D in the dormant season. This chemical is also more effective on hard-to-kill species such as red maple, hickory, blackgum, and eastern redcedar. Because of the lower required application rates, it is as cheap to use as 2,4-D. Tordon 101 is used undiluted at ½ milliliter per injection. Tordon 101R Forestry Herbicide is equivalent in active ingredients to a one-to-one dilution of Tordon 101 and should be used undiluted at 1 milliliter per injection.

Application of herbicides by tree injection will release these pine seedlings.

* Mr. Williston and Mr. Balmer are softwood specialists. Mr. Abrahamson was a pesticide specialist with the Southeastern Area at the time this publication was prepared.

Tests on relative susceptibility of hardwoods to kill by 2,4-D, 2,4,5-T, and picloram plus 2,4-D have produced slightly contradictory results. Hardwoods respond differently, depending upon whether they are on- or off-site and near the limits of their range. Other factors include the season of the year, and the soil moisture at the time of treatment. Where there is any question, local, small-scale tests should be conducted before treating sizable acreages. Most species are far more susceptible to kill in the spring. Wider spacing between incisions can be employed then, with substantial savings in cost.

The Hypo-Hatchet is an alternative tool for injecting 2,4-D into unwanted hardwoods, especially large culls.

GUIDELINES: *Easy-to-kill hardwoods (See table 1) should be injected during the growing season with 1 milliliter (ml.) per jab of undiluted 2,4-D amine in incisions spaced 2 inches apart edge-to-edge. With resistant hardwoods, the incisions should be made edge-to-edge around the base of the tree. During the dormant season or where the majority of species to be treated are resistant to 2,4-D, use Tordon 101R in the same manner.*

Table 1. — Relative susceptibility of hardwoods and redcedar to herbicides 1/

Injection with 2,4-D amine

Susceptible	Intermediate	Resistant
Cherry, black	Beech	Ash, green
Cherry, fire	Blackgum	Ash, white
Cucumbertree	Elm, winged	Dogwood
Elm, American	Hawthorn	Hickory
Oak, black	Hornbeam, American	Holly
Oak, blackjack	Huckleberry	Locust, water
Oak, overcup	Locust, black	Maple, red
Oak, post	Oak, water	Oak, chestnut
Oak, scarlet	Pecan, bitter	Privet, swamp
Oak, southern red	Persimmon, eastern	Redcedar, eastern
Oak, white	Sumac	Sourwood
Oak, willow	Sweetbay	
Sassafrass	Sweetgum	
Willow		
Witchhazel		
Yellow-poplar		

Injection with Picloram + 2,4-D (Tordon 101)

Susceptible	Intermediate	Resistant
Cherry, black	Blackgum	Ash
Hornbeam, American	Boxelder	Dogwood, rough leaf
Locust, black	Hickory	
Maple red (except when sap is flowing)	Persimmon, eastern	
Oak, black	Redcedar, eastern	
Oak, blackjack	Sourwood	
Oak, chestnut	Sweetbay	
Oak, post		
Oak, scarlet		
Oak, southern red		
Oak, white		

1/ General guide only. Susceptibility of species varies with conditions at time of treatment.

MIST BLOWING

Ground spraying with a tractor-mounted mist blower is an approved practice in some States. This approach is the most practical control procedure when the overstory is too dense to treat from the air, the understory is too large for prescribed fire, and there are too many small stems per acre for tree injection. Some advantages of mist blowing over aerial spraying and high-volume ground spraying are (a) efficient treatment of small or irregularly shaped areas, (b) small hazard of drift, (c) good coverage of foliage of understory plants, and (d) a volume of herbicide and carrier for ground spraying which is as low as that required by aerial spraying. Backpack mist blowers are effective on small or remote tracts where aerial and heavy ground equipment are not feasible.

The variables that seem to have the most influence on effectiveness of treatment are average height of the understory, number of hard-to-kill species present in the understory, selective properties of the chemical, and type of carrier used. Mist blowing is effective on blackgum, grape, white oak, post oak, blackjack oak, southern red oak, yellow-poplar, and sweetgum. Species resistant to mist blowing are American hornbeam, red maple, dogwood, yaupon, holly, waxmyrtle, American beautyberry, southern bayberry, French mulberry, water oak, willow oak, hickory, elm, and ash. Mist blowing is also ineffective where the site is poor for pine.

Pine seedlings growing in this cutover area will need to be released from competition from other trees. Mist blowing or aerial spraying will do the job.

The effective zone of control in mist blower operations generally includes stems less than 3 inches in diameter and less than 20 feet tall. Pine mortality is generally less than 10 percent, with susceptible hardwood kill ranging from 40 to 60 percent. The kill can be increased by following the mist blowing operation with a burn late in the growing season if the objective is site preparation and there are no young pines on the area. Where pines are present, it is often necessary to do additional release work with some other method such as injection of the larger hardwoods. Application of the herbicide in concentrated form has been tried, but offers very little promise.

GUIDELINES: *To release pine, use a low-volatile ester of 2,4,5-T applied at a rate of 2 pounds per acre in water at a rate of 5 to 15 gallons per acre. For site preparation, use a low-volatile ester of 2,4,5-T applied at a rate of 4 to 12 pounds per acre plus 1 gallon of oil in enough water to make 10 to 30 gallons of spray per acre. Spray after the trees are in full leaf. Keep in mind that oil damages young pine. Do not spray during or immediately following periods of drought: herbicide effectiveness is better when there is plenty of soil moisture. Spray when the wind is less than 5 miles per hour (mi/h) at the point of discharge. The average droplet size should be about 90 microns, and spray swaths should be about 33 feet apart. Stop spraying when the leaves begin to harden off, generally in late July or early August. A rough appraisal of relative susceptibility of some species is given in table 2.*

Table 2. — Relative susceptibility of hardwoods to foliar application of 2,4,5-T ester. 1/

Susceptible	Intermediate	Resistant
Blackgum	Beautyberry, American	Ash
Cherry, black*	Elm, American	Dogwood
Hackberry	Hickory	Elm, winged
Sassafrass*	Locust, black*	Hawthorn
Sumac	Oak, black	Holly
Sweetgum*	Oak, blackjack	Huckleberry
Sycamore	Oak, northern red	Ironwood
Willow	Oak, post	Maple, red
Yellow-poplar	Oak, southern red	Oak, chestnut
	Oak, white	Oak, live
	Oak, willow	Oak, water
	Persimmon, eastern*	Sourwood
	Waxmyrtle	Sweetbay
		Yaupon

* Prolific root sprouters

1/ General guide only. Susceptibility of species varies with conditions at time of treatment.

AERIAL SPRAYING

Aerial spraying is a foliar treatment suitable for relatively large areas. It can be done to release a pine understory or to prepare an area for planting by a temporary reduction in competition of hardwood brush and trees.

Helicopter sprays remote upland area with herbicide to control hardwood brush before planting. (Photo courtesy Southern Forest Institute.)

Either helicopters or airplanes may be used, depending on the size, shape, and topography of the area and the distance from the nearest available air strip. Airplanes can do the job more cheaply where the topography is relatively gentle. The helicopter gives better results where the topography is rough or the brush consists of hard-to-control species. Advantages of helicopters include their slower speed, uniform spraying height, and the downdrafts of the rotor. Although helicopter spraying is usually more expensive, it may be cheaper when the nearest available airport is many miles from the tract to be treated.

Low volatile esters of 2,4,5-T or 2,4,5-TP (silvex) are most commonly used at the rate of 2 pounds acid equivalent per acre dispensed at a volume of 5 to 15 gallons per acre. The silvicide is mixed with water if young pines are to be released. As the leaves harden off or if there are no pines that might be damaged, diesel oil (No. 1 or No. 2), fuel oil or kerosene may be used as part of the diluent. The amount of silvicide prescribed per acre depends upon the time of year, number of pines present, and the percentage of hard-to-kill species present.

The best time of year to spray is just after the hardwoods have fully leafed out. In most areas in the South this will be in May and early June. For the best kills, the soil should have adequate moisture for good growth at the time of spraying and for several weeks thereafter. Air temperature at the time of spraying should be 65° to 80° F. Temperatures higher than 90° during times of low humidity — when plant transpiration exceeds water absorption — will reduce herbicidal translocation and will rapidly evaporate water carriers. Temperatures above 90° may cause chemicals to volatilize and very small droplets could cause extensive damage to cotton, grapes, tomatoes, etc., growing nearby.

Drift is a problem, not only because it may damage vegetation on adjacent properties but because it reduces the efficiency of the treatment.

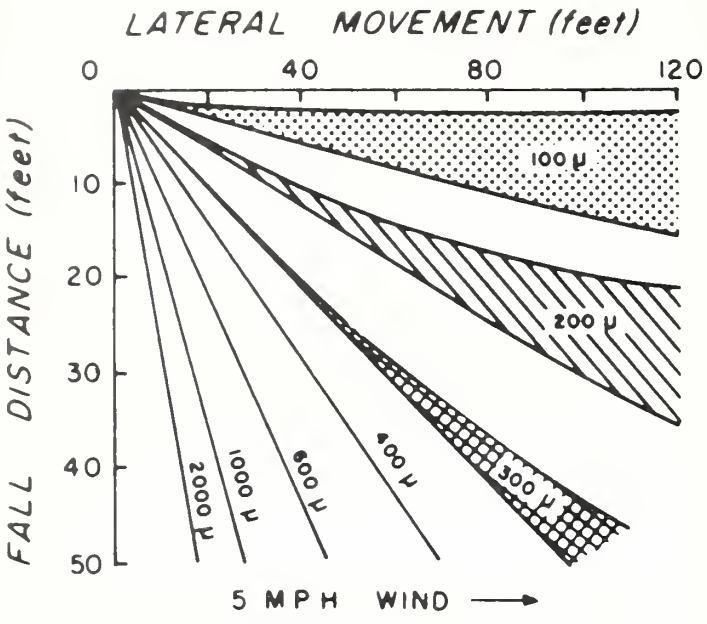

Figure 1. — Lateral movement of spray particles of various diameters falling at terminal velocity in a 5 mi/h cross wind. Shaded areas indicate uncertainty due to varying droplet evaporation.

Spray drift is influenced to a great extent by meteorological conditions and spray droplet size. Drift may be minimized by use of the microfoil boom, which produces droplets with mass median diameters from 800 to 1,700 microns. Such droplets drift little in winds up to 12 mi/h. Figure 1 illustrates the effect of fall distance and droplet size on lateral movement when the wind is 5 mi/h.

Most States have laws prohibiting aerial spraying near susceptible crops, varying from 0.5 to 1 mile in extent. Some States do not allow aerial application at all in cotton or tomato growing areas after April 1 to April 15. Spraying near and over lakes, streams, and ponds is prohibited.

Boundaries of the tract to be sprayed must be clearly identified for the pilot. One cheap way is to deaden hardwoods along the boundary far enough in advance so that their brown tops are distinguishable. For precision swath location, it is necessary to use flagmen who move after each swath is completed.

Rarely is a complete kill of hardwoods obtained. Frequently, a follow-up spray or "touch up" with tree injectors is necessary. In Louisiana, species in order of descending susceptibility to damage by 2,4,5-T ester are: sweetgum, post oak, blackjack oak, black oak, southern red oak, blackgum, white oak, hickory, water oak, winged elm, and red maple.

Silvex ester, applied as a foliar spray, is as effective as 2,4,5-T on oaks, slightly better on maple, slightly poorer on hickories, and much poorer on sweetgum and blackgum. Amines of silvex and 2,4,5-T are not as effective as esters. Defoliation during the first year defines the upper limit of expectable topkill, and this limit may be useful in deciding whether retreatment will be required.

Spraying contracts should include provision for (1) properly licensed plane and pilot, (2) proof of Workmen's Compensation Insurance, (3) exemption of the company, agency or individual from damage claims based on injury to pilot or damage to plane resulting from service performed, (4) supplies to be furnished, (5) description of area to be sprayed, including acreage, (6) rate of application in gallons per acre, (7) exact description of chemical to be used and rate per acre, (8) responsibility of operator for proper application, (9) respraying if needed, (10) method of application, (11) responsibility for directing spraying, (12) dates and times of spraying, (13) marking tract boundaries and flight lines, (14) rate of pay and (15) crop insurance in case adjacent crops are damaged.

GUIDELINES: *To release pine, spray areas of large, low-value hardwoods and/or large areas of small hardwoods, i.e., less than 3 inches d.b.h. and 20 feet tall, with 2 pounds per acre of 2,4,5-T in 5 to 15 gallons of water. For site preparation, spray the hardwoods with 4-8 pounds of 2,4,5-T or a 1:1 mixture of 2,4-D and 2,4,5-T in 10-15 gallons of water. Spray only when the wind is less than 5 mi/h. Start spraying in early May and continue through June as long as the brush is actively growing. As the leaves harden off and where there are no pines that might be burned, 1 pint to 1 gallon of diesel oil may be added to the mixture to make it stick to the leaves better. Burn site-prepared areas in the late summer. Do not attempt to judge the success of the aerial spraying before the end of the second year.*

SOIL TREATMENT

Soil "sterilants" were first used in the woods to control unwanted invaders such as honeysuckle and kudzu. Because they kill pines as well as hardwoods, their use is clearly limited in pine and oak-pine stands. They are also quite expensive. Recently, however, they have shown increasing promise in the conversion of low value hardwood stands to pine, particularly where high-cost mechanical methods of site preparation are customarily employed or where steep grades and danger of erosion preclude mechanical site preparation. They also have merit in areas where drift or volatility of phenoxys are a concern.

Bromacil, applied at a rate of 2 pounds per gallon, is effective either as a broadcast or spot treatment. The chemical activity of bromacil when sprayed on the ground is dependent upon the rainfall. The chemical is root absorbed with the soil water and translocated to the leaves where it interferes with the manufacture of food. Treatment is most effective from mid-February to August. Dosage rates should be higher on soils high in organic matter or carbon.

Susceptible species include blackgum, boxelder, cottonwood, most elms, hackberry, hawthorn, American hornbeam, red maple, the oaks, persimmon, pine, sweetgum, willow, and yellow-poplar. Some of the harder to kill species are ash, redcedar, slippery elm, hickory, black locust, mulberry, osage-orange, pecan, sassafrass, sourwood, haw, wax-myrtle, holly, and sycamore.

GUIDELINES: *Consider using soil sterilants on tracts too small or not suitable for site preparation equipment or where there are only a few scattered hardwoods. As a broadcast treatment, apply 2¼ to 5 gallons per acre of bromacil in the spring and early summer to control susceptible species, and 6 to 12 gallons per acre to control the more resistant species. The chemical can be diluted in up to 100 gallons of water per acre to make treatment easier. As a spot treatment for scattered trees, mix 1 gallon in 5 gallons of water and apply to the base of the tree at the rate of 1 to 2 fluid ounces per 2-inch basal stem diameter. Do not use bromacil where the chemical can get into a stream or other body of water or where there are desirable trees that are to be saved.*

CONTROL OF HONEYSUCKLE AND KUDZU

Japanese honeysuckle is difficult to control because it can become established from seed or propagated from stolons. The drastic site preparation measures in vogue today have resulted in more sunlight on the forest floor and less competition for soil moisture. Hence, honeysuckle has become a serious problem for natural regeneration of pine as well as for artificially regenerated stands by smothering small seedlings or saplings to death. Kudzu, which has been widely planted for erosion control and roadbank stabilization, will also smother young trees and deform large ones.

Currently, the chemicals proven most effective for control of these vines are picloram + 2,4-D. These two herbicides are combined in liquid form as Tordon 101 mixture weed and brush killer and in pellet form as Tordon 10K Pellets brush killer. The pellets killed honeysuckle when applied at rates of 60 to 80 pounds per acre, and permitted the establishment of loblolly pine in Alabama. The pellets also proved effective against kudzu when used at rates of 40 to 60 pounds per acre. However, such treatments should be used with caution because they also killed 97 percent or more of the hardwood and pines 4.5 feet and taller.

Another treatment developed in Georgia combines fire and chemicals to control kudzu. A dormant season burn reduces litter buildup and facilitates treatment. This is followed by application of 35 to 75 pounds of 10K Pellets per acre in the early spring, the rate depending upon crown density. During the late spring, individual crowns and sprigs are treated with 1 teaspoonful of Tordon 10K. Follow-up examination and retreatment of any surviving crowns are necessary until there are no live kudzu crowns.

Avoid applying Tordon to areas from which it can be washed into areas growing desirable species. Do not apply on stream banks or close to any water.

GUIDELINES: *Burn or disk honeysuckle and kudzu during the dormant season. Honeysuckle has persistent leaves and may be more difficult to burn in the dormant season. Just prior to crown sprouting, broadcast 60 pounds per acre of Tordon 10K Pellets. Sixty to 90 days later, spot treat any surviving crowns with one teaspoonful of pellets. Pines may be planted during the dormant season. Spot treat any surviving crowns during the spring of the second year.*

Herbicide pellets controlled kudzu in foreground. Kudzu is taking over the untreated area in background.

COST

Some of the factors affecting chemical control of unwanted vegetation are method of treatment, labor supply, wage rates, equipment rates, chemical cost, species mix, stand density, size of tract to be treated, availability of contractors, degree of competition among contractors and ease of access. It should be quite clear, with so many variables, that any cost figures cited are both quite local and fleeting in nature. Even so, the cheapest forestland one can buy is that obtained by deadening low value hardwoods on land already owned.

PRECAUTIONARY MEASURES

1. Before embarking on a large-scale operation, test the proposed treatment on a small area. Reponses to chemical treatments vary according to the geographic province.
2. Have a written contract with the operator, spelling out in detail the prescription he is to follow, or provide him with a copy of FIP or ACP management plan.
3. Take into account the soil moisture as well as the weather in scheduling the time of silvicidal application.
4. Make sure the injection prescription you adopt is for the blade width of the injector you propose to use. If not, modify the injector spacing. Tree injector blades or bits come in varying widths from 1¼ to 3 inches.
5. Consider the impact on roadside aesthetics of the proposed treatment.
6. Inform the owner of neighboring tracts what you propose to do before starting treatment.
7. Always follow the manufacturer's label instructions given on the silvicide container.
8. Know your State laws on the use of pesticides, and heed them.
9. Do not indiscriminately discard pesticides containers. Damage them so that they cannot be reused and dispose of them in a safe and approved manner. Check labels for manufacturer's recommendations.

NOTE: Mention of a product name does not endorse that product as the only available material, but is based on information available to the authors. Herbicides must be registered by appropriate State and Federal agencies. Check manufacturers' labels for registered use and precautions.

Appreciation is extended to the following field units assisting in the preparation of this bulletin: Georgia Kraft Company, Hamilton, Alabama; Dow Chemical Company; Tennessee River Pulp and Paper Company, Savannah, Tennessee; Ozark National Forest, Russellville, Arkansas; and the Southern Forest Experiment Station, Pineville, Louisiana.

SUGGESTED READING

1. Brady, H. A., F. A. Peevy and P. Y. Burns.
1969. Erratic results from aerial spraying of mid-South hardwoods. J. For. 67:393-396.
2. Brender, E. V. and E. L. Moyer.
1965. Further progress in the control of kudzu. Down to Earth 20(4): 16, 17.
3. Burns, P. Y.
1960. Use of aircraft for foliar applications of herbicides in southern forests. Proc. LSU For. Symp. 9:84-100.
4. _____ and W. L. Smiley.
1962. Tentative recommendations for using tractor-mounted mist blowers in the South. LSU For. Note 50.
5. Byrnes, W. R., and H. A. Holt, eds.
1975. Herbicides in Forestry. Dept. of For. & Nat. Resources, Purdue Univ.
6. Nation, H. A.
1967. Report on tree control via injection with Tordon 101 mixture. Down to Earth. 23(2):24-27.
7. Peevy, F. A.
1968. Controlling upland southern hardwoods by injecting undiluted 2,4-D amine. J. For. 66:483-487.
8. _____
1968. Injecting undiluted 2,4-D amine for control of bottomland hardwoods. Proc. South. Weed Conf. 21:223-227.
9. _____
1971. Wide-spaced injectors of herbicidal mixtures for controlling weed trees. Proc. South. Weed Conf. 24:263-267.
10. _____
1972. Injection treatments for controlling resistant hardwood species. Proc. South. Weed Conf. 25:252-256.
11. _____
1972. Injection treatments for killing bottom-land hardwoods. Weed Science 20(6):566-568.
12. _____
1973. Bromacil and picloram under southern upland hardwoods. Weed Science 21(1):54-56.
13. _____and H. A. Brady.
1968. Mist blowing versus other methods of foliar spraying for hardwood control. Weed Science 16(4):425-426.
14. Prine, E. L. and J. W. Starr.
1971. Herbicide control of Japanese honeysuckle in forest stands. Proc. South. Weed Conf. 24:298-300.
15. Reimer, C. A., B. C. Byrd, and J. H. Davidson.
1966. An improved helicopter system for the aerial application of sprays containing Tordon 101 mixture particulated with Norbak. Down to Earth 22(1):3-6.
16. Romancier, R. M.
1965. 2,4-D, 2,4,5-T and related chemicals for woody plant control in the Southeastern United States. Georgia For. Res. Counc. Rep. No. 16.
17. Starr, J. W.
1971. Site preparation using a tractor mounted mist blower. Proc. South. Weed Conf. 24:275-285.
18. Whipple, S. D. and K. P. Moeck.
1968. Potential uses of Tordon 10K Pellets in forest management. Down to Earth 24(1):13-17.